NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

POND

(No.)

CODE 378

DEFINITION

A water impoundment made by constructing an embankment or by excavating a pit or dugout.

In this standard, ponds constructed by the first method are referred to as embankment ponds, and those constructed by the second method are referred to as excavated ponds. Ponds constructed by both the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at the auxiliary spillway elevation is 3 feet or more.

PURPOSE

To provide water for livestock, fish and wildlife, recreation, fire control, and other related uses and to maintain or improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This standard establishes the minimum acceptable quality for the design and construction of low hazard ponds (dams) where:

1. Failure of the dam will not result in loss of life; damage to homes, commercial or industrial buildings, main highways, or railroads; or interruption of the use or service of public utilities.
2. The product of the storage times the effective height of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the auxiliary spillway. The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no auxiliary spillway, the top of the dam is the upper limit.
3. The effective height of the dam is 35 feet or less.

Dams exceeding the limitations listed above and any significant hazard or high hazard dams as defined in National Engineering Manual (NEM) Part 520 will meet or exceed the requirements of Technical Release No. 60, “Earth Dams and Reservoirs.”

(Note: Hazard class designations a, b, and c are being phased out and replaced with low, significant, and high.)

GENERAL CRITERIA APPLICABLE TO ALL PURPOSES

Laws, rules, and regulations. This practice shall conform to all federal, state, and local laws, rules, and regulations. Laws, rules, and regulations of particular concern include those involving water rights, land use, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.

The owner is responsible for securing necessary permits, complying with all laws and regulations, and meeting legal requirements applicable to the installation and operation and maintenance of the pond and associated structures

Vegetation and fencing. The exposed surfaces of the embankment, auxiliary spillway, outlet channel, borrow area, spoil, and other disturbed areas adjacent to the reservoir area shall be seeded. Seedbed preparation, seeding, fertilizing, and mulching shall comply with Conservation Practice Standard 342, Critical Area Planting.

Fencing shall be installed as required for the protection of vegetation and for safety considerations. Fencing shall comply with Conservation Practice Standard 382, Fencing.

Site conditions. Site conditions shall be such that runoff from the design storm can be safely passed through (1) a natural or constructed auxiliary spillway, (2) a combination of a principal spillway and an auxiliary spillway, or (3) a principal spillway.

Drainage area. The drainage area above the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. The drainage area shall be large enough so that surface runoff and groundwater will provide an adequate supply of water for the intended purpose unless an alternate water source exists to serve this purpose. The quality shall be suitable for the water's intended use.

Reservoir area. The topography and geology of the site shall permit storage of water at a depth and volume that will ensure a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. If surface runoff is the primary source of water for a pond, the soils shall be impervious enough to prevent excessive seepage losses or shall be of a type that sealing is practicable.

DESIGN CRITERIA FOR EMBANKMENT PONDS

Geological investigations. Pits, trenches, borings, review of existing data, or other suitable means of investigation shall be conducted to characterize materials within the embankment foundation, auxiliary spillway, and borrow areas. Soil materials shall be classified using the Unified Soil Classification System.

Foundation cutoff. A cutoff of relatively impervious material shall be provided under the dam if necessary to reduce seepage through the foundation. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments as required and be deep enough to extend into a relatively impervious layer or provide for a stable dam when combined with seepage control. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes shall not be steeper than 1 horizontal to 1 vertical.

Seepage control. Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage could create swamping downstream, (3) such control is needed to ensure a stable embankment, or (4) special problems require drainage for a stable dam. Seepage may be controlled by (1) foundation, abutment, or embankment filters and drains; (2) reservoir blanketing; or (3) a combination of these measures.

Embankment. The minimum top width for a dam is shown in Table 1. If the embankment top is to be used as a public road, the minimum width shall be 16 feet for one-way traffic and 26 feet for two-way traffic. Guardrails or other safety measures shall be used where necessary and shall meet the requirements of the responsible road authority. For dams less than 20 feet in height, maintenance considerations or construction equipment limitations may require increased top widths from the minimum shown in Table 1.

Table 1. - Minimum top width for dams

Total Height of Embankment (feet)	Top Width (feet)
Less than 10	6
10 to less than15	8
15 to less than 20	10
20 to less than 25	12
25 to less than 35	14
35 or more	15

Note: For this standard, the maximum effective height of the dam is 35 feet.

Side slopes. Side slopes shall not be steeper than is shown in Table 2. All slopes must be designed to be stable, even if flatter side slopes are required. Downstream or upstream berms can be used to help achieve stable embankment sections.

Table 2. - Minimum side slopes

Total Height of Embankment (feet)	Upstream Slope	Downstream Slope
Less than 12	3:1	2:1
Greater than or equal to 12	3:1	2 1/2:1

Slope protection. If needed to protect the slopes of the dam from erosion, special measures such as berms, rock riprap, sand-gravel, soil cement, or special vegetation shall be provided. (Technical Release 56, "A Guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments," and Technical Release 69, "Riprap for Slope Protection Against Wave Action," contain design guidance.)

Freeboard. The minimum elevation of the top of the settled embankment shall be 1 foot above the water surface in the reservoir with the auxiliary spillway flowing at design depth. The minimum difference in elevation between the crest of the auxiliary spillway and the settled top of the dam shall be 2 feet for all dams having more than a 20-acre drainage area or more than 20 feet in effective height.

Settlement. The design height of the dam shall be increased by the amount needed to ensure that after settlement the height of the dam equals or exceeds the design height. This increase shall not be less than 5 percent of the height of the dam, except where detailed soil testing and laboratory analyses or experience in the area show that a lesser amount is adequate.

Principal spillway. A pipe conduit, with needed appurtenances, shall be placed under or through the dam, except where rock, concrete, or other types of lined spillways are used or where the rate and duration of flow can be safely handled by a vegetated or earth spillway.

For dams with a drainage area of 20 acres or less, the principal spillway crest elevation shall not be less than 0.5 foot below the auxiliary spillway crest elevation. For dams with a drainage area over 20 acres, this difference shall not be less than 1 foot.

When design discharge of the principal spillway is considered in calculating peak outflow through the auxiliary spillway, the crest elevation of the inlet shall be such that the design discharge will be generated in the conduit before there is discharge through the auxiliary spillway.

Pipe conduits designed for pressure flow must have adequate anti-vortex devices. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the auxiliary spillways. The diameter of the principal spillway pipe shall not be less than 4 inches. Pipe conduits used solely as a supply pipe through the dam for watering troughs and other appurtenances shall not be less than 1¼ inches in diameter.

If the pipe conduit diameter is 10 inches or greater, its design discharge may be considered when calculating the peak outflow rate through the auxiliary spillway.

Pipe conduits shall be ductile iron, welded steel, corrugated steel, corrugated aluminum, reinforced concrete (precast or sitecast), or plastic. Pipe conduits through dams of less than 20 feet total height may also be cast iron or unreinforced concrete.

Pipe conduits shall be designed and installed to withstand all external and internal loads without yielding, buckling, or cracking. Rigid pipe shall be designed for a positive projecting condition. Flexible pipe strength shall not be less than necessary to support the design load with a maximum deflection of 5 percent. The modulus of elasticity for PVC pipe shall be assumed as one-third of the amount designated by the compound cell classification to account for long term reduction in modulus of elasticity. Different reductions in modulus may be appropriate for other plastic pipe materials.

The minimum thickness of flexible pipe shall be SDR 26, Schedule 40, Class 100, or 16 gage as appropriate for the particular pipe material. Table 3 and Table 4 provide details. Connections of flexible pipe to rigid pipe or other structures shall be designed to

accommodate differential movements and stress concentrations.

All pipe conduits shall be designed and installed to be watertight by means of couplings, gaskets, caulking, waterstops, or welding. Joints shall be designed to remain watertight under all internal and external loading including pipe elongation due to foundation settlement.

Pipe conduits shall have a concrete cradle or bedding if needed to provide improved support for the pipe to reduce or limit structural loading on pipe to allowable levels.

Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Other suitable devices such as a Saint Anthony Falls stilling basin or an impact basin may be used to provide a safe outlet.

Table 3. - Acceptable PVC* pipe for use in earth dams

Nominal Pipe Size (inches)	Schedule or Standard Dimension Ratio (SDR)	Maximum Depth of Fill over Pipe (feet)
1 1/2**, 2**	Schedule 40 or 80 or SDR 13.5	30
4**	Schedule 40 or SDR 17	20
6, 8, 10, 12	Schedule 40 or SDR 26	10
6, 8, 10, 12	SDR 21	12
6, 8	Schedule 80 or SDR 17	15
10, 12	Schedule 80	15

* Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM D 1785 or ASTM D 2241
** Limited to water supply lines

Table 4. - Minimum thickness - corrugated metal pipe

Pipe Dia. (inches)	Steel with 2 2/3 In. x 1/2 In. Corrugation (gage)			Steel with 3 In. x 1 In. Corrugation (gage)			Aluminum* with 2 2/3 In. x 1/2 In. Corrugation		
	Fill Height Above Pipe (feet)								
	<15	15-20	20-25	<15	15-20	20-25	<15	15-20	20-25
21 & Less	16	16	16	--	--	--	.06	.06	.06
24	16	16	16	--	--	--	.06	.075	.105
30	16	16	14	--	--	--	.075	.105	.135
36	14	14	12	16	16	16	.075	.105	**
42	12	12	10	16	16	16	**	**	--
48	10	10	10	16	16	14	--	--	--
54	--	--	--	16	16	12	--	--	--
60	--	--	--	16	14	10	--	--	--
66	--	--	--	16	14	8	--	--	--
72	--	--	--	16	14	8	--	--	--

* Riveted or helical fabrication
** Not permitted

All steel pipe and couplings shall have protective coatings in areas that have traditionally experienced pipe corrosion or in embankments with saturated soil resistivity less than 4000 ohms-cm or soil pH less than 5. Protective coatings shall be asphalt, polymer-over-galvanized, aluminized or coal-tar enamel as appropriate for the pipe type. Plastic pipe that will be exposed to direct sunlight shall be ultraviolet-resistant and protected with a coating or shielding or provisions provided for replacement as necessary.

Cathodic protection. Cathodic protection is to be provided for coated welded steel and galvanized corrugated metal pipe where soil and resistivity studies indicate that the pipe needs a protective coating and where the need and importance of the structure warrant additional protection and longevity. If cathodic protection is not provided for in the original design and installation, electrical continuity in the form of joint-bridging straps should be considered on pipes that have protective coatings. Cathodic protection should be added later if monitoring indicates the need.

Seepage control. Seepage control along a pipe conduit spillway shall be provided if any of the following conditions exist:

1. The effective height of dam is greater than 15 feet.
2. The conduit is of smooth pipe larger than 8 inches in diameter.
3. The conduit is of corrugated pipe larger than 12 inches in diameter.

Seepage along pipes extending through the embankment shall be controlled by use of a drainage diaphragm, unless it is determined that antiseep collars will adequately serve the purpose.

Drainage diaphragm. The drainage diaphragm shall function both as a filter for adjacent base soils and a drain for seepage that it intercepts. The drainage diaphragm shall consist of sand meeting the requirements of ASTM C 33 for fine aggregate. If unusual soil conditions exist such that this material may not meet the required filter or capacity requirements, a special design analysis shall be made.

The drainage diaphragm shall be a minimum of 2 feet thick and extend vertically upward and horizontally at least 3 times the outside pipe diameter and vertically downward at least 18 inches beneath the conduit invert. The drainage diaphragm shall be located immediately downstream of the cutoff trench but downstream of the centerline of the dam if the cutoff is upstream of the centerline.

The drainage diaphragm shall be outletted at the downstream toe of the embankment using a drain backfill envelope continuously along the pipe to where it exits the embankment or by using a drain pipe. Drain fill shall be protected from surface erosion.

Antiseep collars. When antiseep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe but not more than 25 feet. The minimum spacing shall be 10 feet. Collar material shall be compatible with pipe materials. The antiseep collar(s) shall increase by at least 15 percent the seepage path along the pipe.

Trash guard. To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser unless the watershed does not contain trash or debris that could clog the conduit.

Anti-vortex device. Closed conduit spillways designed for pressure flow must have adequate anti-vortex devices.

Other outlets. A pipe with a suitable valve shall be provided to drain the pool area if needed for proper pond management or if required by state law. The principal spillway conduit may be used as a pond drain if it is located where it can perform this function.

Auxiliary spillways. Auxiliary spillways convey large flood flows safely past earth embankments and have historically been referred to as “emergency spillways.”

An auxiliary spillway must be provided for each dam unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam. The following are minimum criteria for acceptable use of a closed conduit principal spillway

without an auxiliary spillway: a conduit with a cross-sectional area of 3 square feet or more, an inlet that will not clog, and an elbow designed to facilitate the passage of trash.

The minimum capacity of a natural or constructed auxiliary spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 5 less any reduction creditable to conduit discharge and detention storage.

Table 5. - Minimum auxiliary spillway capacity

Drainage Area (acre)	Effective Height of Dam 1/ (feet)	Storage (ac. ft.)	Minimum Design Storm 2/ Frequency (years)	Min. Duration (hours)
20 or less	20 or less	less than 50	10	24
20 or less	over 20	less than 50	25	24
over 20		less than 50	25	24
All Others			50	24

1/ As defined under “CONDITIONS WHERE PRACTICE APPLIES”
2/ Select rain distribution based on climatological region

The auxiliary spillway shall safely pass the peak flow, or the storm runoff shall be routed through the reservoir. The routing shall start either with the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days’ drawdown, whichever is higher. The 10-day drawdown shall be computed from the crest of the auxiliary spillway or from the elevation that would be attained if the entire design storm were impounded, whichever is lower. Auxiliary spillways shall provide for passing the design flow at a safe velocity to a point downstream where the dam will not be endangered.

Constructed auxiliary spillways are open channels that usually consist of an inlet channel, a control section, and an exit channel. They shall be trapezoidal and shall be located in undisturbed or compacted earth or in-situ rock. The side slopes shall be stable for the material in which the spillway is to be constructed and not less than 2:1 in earth materials. For dams having an effective height exceeding 20 feet, the auxiliary spillway shall have a bottom width of not less than 10 feet.

Upstream from the control section, the inlet channel shall be level for the distance needed to protect and maintain the crest elevation of the spillway but not less than 20 feet. The inlet channel may be curved to fit existing topography. The grade of the exit channel of a constructed auxiliary spillway shall fall within the range established by discharge requirements and permissible velocities.

Structural auxiliary spillways. If chutes or drops are used for principal spillways or auxiliary spillways, they shall be designed according to the principles set forth in National Engineering Handbook Part 650, Engineering Field Handbook, and National Engineering Handbook (NEH), Section 5, Hydraulics; NEH Section 11, Drop Spillways; and NEH Section 14, Chute Spillways. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 5 less any reduction creditable to conduit discharge and detention storage.

CRITERIA FOR EXCAVATED PONDS

Runoff. Provisions shall be made for a pipe and auxiliary spillway (when embankments are part of excavated pond design) that will meet the capacity requirements of Table 5. Runoff flow patterns shall be considered when locating the excavated pond and placing the spoil.

Side slopes. Side slopes of excavated ponds shall be stable and shall not be steeper than 1 horizontal to 1 vertical. If livestock will water directly from the pond, a watering ramp of ample width shall be provided. The ramp shall

extend to the anticipated low water elevation at a slope no steeper than 3 horizontal to 1 vertical.

Inlet protection. If surface water enters the pond in a natural or excavated channel, the side slope of the pond shall be protected against erosion.

Excavated material. The material excavated from the pond shall be placed so that its weight will not endanger the stability of the pond side slopes and it will not be washed back into the pond by rainfall. Spoil must not be placed in a manner that will cause erosion, restrict runoff, or limit flood plain capacity. It shall be disposed of in one of the following ways:

1. Uniformly spread to a height that does not exceed 3 feet, with the top graded to a continuous slope away from the pond.
2. Uniformly placed or shaped reasonably well, with side slopes assuming a natural angle of repose. The excavated material will be placed at a distance equal to the depth of the pond but not less than 12 feet from the edge of the pond.
3. Shaped to a designed form that blends visually with the landscape.
4. Used for low embankment construction and leveling of surrounding landscape.
5. Hauled away.

CONSIDERATIONS

Visual resource design. The visual design of ponds should be carefully considered in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

The embankment may be shaped to blend with the natural topography. The edge of the pond may be shaped so that it is generally curvilinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, islands may be added for visual interest and to attract wildlife.

Cultural resources. Consider existence of cultural resources in the project area and any project impacts on such resources. Consider conservation and stabilization of archeological, historic, structural, and traditional cultural properties when appropriate.

Fish and wildlife.

1. Project location and construction should minimize the impacts to existing fish and wildlife habitat.
2. When feasible, structure should be retained such as trees in the upper reaches of the pond and stumps in the pool area. Upper reaches of the pond can be shaped to provide shallow areas and wetland habitat.
3. If fish are to be stocked, consider criteria and guidance in Conservation Practice Standard 399, Fishpond Management.

Vegetation

Consider the following:

1. Selection and placement of vegetation to protect all disturbed areas from erosion - Refer to Conservation Practice Standard 342, Critical Area Planting.
2. Topsoil stockpiling for placement on disturbed areas to facilitate revegetation.
3. Placement and selection of vegetation to improve fish and wildlife habitat and species diversity.

Water quantity

Consider the following:

1. Effects upon components of the water budget, especially effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.
2. Variability of effects caused by seasonal or climatic changes.
3. Effects on downstream flows and impacts to the environment (such as wetlands and aquifers) and the social and economic impacts to downstream uses or users.
4. Potential for multiple purposes.

Water quality

Consider the following:

1. Effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that are carried by runoff.
2. Effects on the visual quality of onsite and downstream water resources.
3. Short-term and construction-related effects of this practice on the quality of downstream water courses.
4. Effects of water level control on the temperatures of downstream water to prevent undesired effects on aquatic and wildlife communities.
5. Effects on wetlands and water-related wildlife habitats.
6. Effects of water levels on soil nutrient processes such as plant nitrogen use or denitrification.
7. Effects of soil water level control on the salinity of soils, soil water, or downstream water.
8. Potential for earth moving to uncover or redistribute toxic materials such as saline soils.

PLANS AND SPECIFICATIONS

Plans and specifications for installing ponds shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed and reviewed with the landowner or individual responsible for operation and maintenance.